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AUTHOR Glenn, Phillip J.; Koschmann, Timothy; Conlee, Melinda
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ABSTRACT

A study used conversational analysis to examine the reasoning students use in a Problem-Based Learning (PBL) environment as they formulate a theory (in medical contexts, a diagnosis) which accounts for evidence (medical history and symptoms). A videotaped group interaction was analyzed and transcribed. In the segment of interaction examined, the participants considered a theory presented by "Betty," discussed the location of the hippocampus, entertained another theory from Betty, attempted to distinguish a stroke from a transient ischemic attack, and discussed the compatibility of symptoms with Betty's explanations. Betty presented "her" two theories as products of her individual reasoning. However, the "processing" of the theories (including such actions as agreeing, disagreeing, questioning, and modifying) was thoroughly interactional. Findings illustrate the possibilities of close description of PBL interaction and demonstrate conversation analytic description and reasoning. (Contains 18 references.) (RS)

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Theory presentation and assessment in a Problem-Based Learning group

by
Phillip J. Glenn
Department of Speech Communication
Southern Illinois University at Carbondale
Carbondale, IL 62901-6605
618-453-2291
PJGLENN@SIU.EDU

Timothy Koschmann
Center for Life-Long Learning and Design (L3D)
University of Colorado at Boulder
Campus Box
Boulder, CO
303-492-2233
TDK@CS.COLORADO.EDU

Melinda Conlee
Department of Medical Education
Southern Illinois University
School of Medicine
P.O. Box 19230
Springfield, IL 62704-9230
MCONLEE@SIUMED.EDU

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Theory presentation and assessment in a

Problem-Based Learning group

by Phillip J. Glenn, Timothy Koschmann, and Melinda Conlee

One of the stated objectives of Problem-Based Learning (PBL) is for students to practice and develop skills for reasoning in clinical settings, including the ability to formulate a theory (in medical contexts, a diagnosis) which accounts for the evidence (medical history and symptoms) (Barrows, 1994; Koschmann, Kelson, Feltovich, & Barrows, 1996). This reasoning largely occurs in and through meetings conducted by the group to discuss clinical cases. Thus, examination of interactions within these meetings should provide a basis for describing and assessing the reasoning students use.

Reasoning in PBL Meetings

Problem-based learning is undertaken in a variety of ways at different institutions (Barrows, 1986). In this paper we examine an example of interaction within a particular methodological approach to PBL that has been described in greater detail elsewhere (Barrows, 1994; Koschmann et al., 1996).

Within this particular implementation, the exploration of a case proceeds through several phases, namely Problem Formulating, Self-Directed Learning, Knowledge Applying, Abstracting, and Reflecting (Koschmann et al., 1996). The

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group begins by making inquiries into a case and developing a set of hypotheses about source of the patient's problem. The initial phase of Problem Formulating, therefore, may produce instances of the students generating and, in some cases, defending theories about the patient's underlying disorder.

As the students develop a more complete picture of the case under study, they compile a list of areas in which they consider their knowledge to be deficient (Barrows, 1994; Koschmann, Glenn, & Conlee, in press). When this list grows long, the group recesses to allow the students time to research independently these issues, thereby entering into the phase of Self-Directed Learning.

After such a phase of independent work, the group members reconvene and attempt to apply their newly acquired knowledge to the case under study; that is, they begin a phase of Knowledge Applying. Armed with new knowledge, the students may be stimulated to ask new questions about the case. This, in turn, may inspire them to propose new theories or critique previously proposed theories.

The group may repeat cycles of Problem-Formulating, Self-Directed Learning, and Knowledge Applying several times before leaving a case. At appropriate junctures, the members of the group pause to reflect on their methods and contributions (i.e., Reflecting phase) and to make attempts to abstract what they have learned from this particular case (Abstracting phase). Discussion of student theories may also take place in these latter two phases, as when students

evaluate their own theory-making contributions or when they attempt to articulate what they have learned from a particular case.

This iterative process of making inquiries into the patient's problem, proposing theories to account for this problem, and empirically testing these theories was designed to recapitulate the process used by skilled practitioners when problem-solving in clinical practice (Barrows, 1990; Barrows & Feltovich, 1987). The faculty member's role in this process is to model this reasoning strategy while simultaneously helping the students to recognize areas of incomplete understanding of the case.[1]

In this article, we will analyze a segment of interaction that took place during a phase of Knowledge Applying subsequent to a period of Self-Directed Learning. Within this segment, one of the students advances two theories to account for the patient's problem. We describe, therefore, how the theories are introduced and how the members of the group respond to these theories. Through this analysis we hope to show some of the interactional sequences through which group members come to accept or reject theories.

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[1]In medical education the faculty member participating in a PBL group is referred to as the 'tutor.' We have argued elsewhere (Koschmann et al., 1996) that this term may be somewhat misleading. In this article, therefore, we will refer to the faculty member as the 'learning coach' or simply 'coach.'

Applying Conversation Analysis to the Study of Reasoning in Groups

We treat reasoning as jointly-constructed, grounded in and shaped by the sequential organization of interaction. Our approach reflects procedures and assumptions of ethnomethodological conversation analysis (for discussions, see, Atkinson and Heritage, 1984; Psathas, 1995; Pomerantz & Fehr, 1997). Briefly, conversation analysis (CA) methods emphasize close description of recordings of naturally-occurring interactions with the aim of characterizing methods by which people organize their social worlds. CA researchers create detailed transcripts noting speech, paralinguistic and visual behaviors, and aspects of timing and placement; describe the ways people organize sequences of talk; and generalizing from individual cases, derive inductive claims about recurrent features of social interaction. Analysis begins not with hypotheses but rather with open-ended description. The aim is to explicate how people produce interaction and what they accomplish in and through it. The emphasis is not on "why" things happen or people do what they do but on "what" they do and "how" they do it.

The analysis presented below arose from a research process involving the following steps. After viewing the videotaped group interaction, we selected the passage for analysis, drawn to it by Betty's proclamation of "my theory" and the subsequent discussion. We viewed and listened to the segment repeatedly while preparing the detailed transcript.

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In several intensive discussions among the authors (plus other researchers in informal listening sessions) we generated description of ways participants organized the interaction. In this process we relied on terms and descriptions from previous CA research which provide "tools" to aid analysis. Noticing participant orientation to theory presentation and treatment, we chose that as the focus for this article.

When presented in a PBL group meeting, a theory may provide a focus for subsequent talk in which group members evaluate, modify, accept, or reject the theory. They accomplish these actions by such actions as assessing the theory, displaying agreement or disagreement, asking clarifying or critical questions, fitting evidence and reasoning to the theory, or producing alternative theories or accounts for data. In the segment of interaction under consideration here, the participants consider a theory presented by Betty, discuss the location of the hippocampus, entertain another theory from Betty, attempt to distinguish a stroke from a TIA, and discuss the compatibility of symptoms with Betty's explanations. Interestingly, the group members return to the first theory only after considering and rejecting the second. This suggests participation orientation to treating the two theories as part of a larger structure. How they do so, and what they might accomplish through such organization, are the focus of the remaining discussion.

Presentation of Evidence and Reasoning, and Theory: "My Theory"

Immediately prior to the start of this segment, the Coach provides a formulation (Heritage and Watson, 1978) or summary of preceding talk, followed by a conclusion:

Coach:	So he's got speech involvement 'n right leg involvement. (1.0)
Maria:	(Speech involvement) [
Coach:	So- So whatever his problem is: (.) we're pretty confident it's on the left side.

Formulations, by summarizing preceding talk, provide opportunity spaces for interactants to move on to new, possibly related matters. Following the Coach's formulation, one of the students, Betty, introduces information from a book lying in front of her:

|0:20:12:20|Betty: See, what it said here

The imperative "See" brings the attention of the other group members to Betty. "What it said here" further places that focus on the book to which she refers. Both can be heard as preliminary to presenting information from that book. Having thus displayed that she is about to present some information, Betty abandons that course to announce a "theory":

|0:20:12:20|Betty: See, what it said here
n- my theory about this
amnesic (.) dysnomic aphasia?

Since she hasn't yet presented her "theory", this phrase can serve to project that the theory is to follow. Betty has prefaced two actions, each of which could warrant an extended turn at talk: presenting information from a book and offering a theory. She does take an extended turn to do both: she reads from the book and she offers a theory:

	Betty:	n- my theory (1.2) about this
		[[
|0:20:15:00|	Coach:	°mph •hh°
|0:20:15:00|	Betty:	amnesic (.) dysnomic aphasia? (0.6)
		um it says the cause of lesion is
		usually deep in temporal lobe
		just like Maria was saying
		Presumably interrupting
		connections of sensory speech
		areas with the hippocampal and
		parahippocampal regions. (1.0)
		and I think the hippocampus is like
		a lot more medial so if it was
		affecting that area it might be
		the anterior cerebral circulation.

She marks a return to reading (line 14) by the phrase "it says". After reading, she stops (line 16) to indicate that Maria (one of the other students) too had suggested what this book apparently now confirms. This acknowledgment may serve to bring both Maria and "the book" into support for Betty's emerging theory. Betty quotes more from the book (17-20), about consequences of a lesion in the temporal lobe. She stops reading and there is a one second pause (line 21). Under other, someone else might begin speaking at this moment. However, orienting to her announced-but-not-yet-presented theory, the others remain silent, granting her extended turn space. Betty now shows in at least two ways

that she no longer is reading: she looks up to make eye contact with other group members, and by "I think" she marks what is to follow as her idea and as tentative (line 22). Her next statement concerns the location in the brain of the hippocampus, posited as a spatial comparison (line 23: "a lot more medial"). Thus having presented evidence and reasoning, she offers as conclusion the "theory" (23-25) that anterior cerebral circulation is the source of the problem for this patient.

Theory presentation is an integral part of theory construction. Betty's theory presentation occurs through an interweaving of two sequential activities, reading aloud and presenting a theory. She provides book evidence, notes that it supports something another group member had said, provides reasoning, and ends her extended turn with an explanation which stands as a theory. This roughly inductive pattern (evidence + reasoning --> conclusion) places the actual theory at the end of the turn. The silence of other group members during her talk orients to this structure.

Response to Theory: Implicit Endorsement, Information search

As Betty nears completion of her turn, Norman says the word "anterior" in unison with her. This bit of overlapping speech occurs at what elsewhere has been described as a recognition point, an earliest possible moment at which a co-participant may show understanding of the utterance-in-

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progress and may anticipate the substance of utterance completion (see Jefferson, 1973, 58-59).

Betty:	so if it was affecting that area it might be the anterior cerebral circulation.
Norman:	[Anterior.

Norman shows that he follows Betty's reasoning and that he too arrives--independently--at the same conclusion. This may also serve as a way to demonstrate alignment, if not outright agreement, with her theory.

Coach retrieves from Betty's preceding information knowlege which she had marked as tentative (see lines 22-23) and packages it in a question:

Betty:	it might be the anterior cerebral circulation.
10:20:33:00 Norman:	[Anterior.
10:20:35:00 Coach:	Where is the hippocampus.

This initiates an extended series of turns (not described here) devoted to identifying the hippocampus as depicted on flip charts of the brain. This activity is distinct from theory generation, though perhaps relevant to later theory evaluation. This segment terminates with Lil's pointing (with directions from Norman) pointing to one part of a picture, and Coach confirming that the students have successully located the hippocampus:

10:21:33:00 Norman:	Go to the crevice there. (1.0)
Norman:	That little loop? (1.0) ((Lil points to picture))
Norman:	Yeah.

|0:21:37:00|Coach: That's it.

While perhaps marking the end of the searching activity, Coach's confirming "That's it" does not project a next action or select any particular other speaker as next (for rules of speaker selection in conversation, see Sacks, Schegloff, and Jefferson, 1974). Betty takes this opportunity to return to theory presentation.

Alternative Theory with Reasoning and Evidence: "My Other Theory"

Betty now presents a second "theory." As with the previous one, she marks ownership of the theory via a possessive pronoun. This theory stands in contrast to her earlier one, offering "space occupying lesion" as an alternative explanation to "vascular lesion."

|0:21:38:00|Betty: My other theory is that if it was i- i- if it's not a vascular lesion but a space occupying lesion if it was right there ((*points to chart*)) in the area we were pointing to it would be like a posterior limb of the interior capsule which would be where (.) the cortical spinals to the leg would be going through that part.

Betty attempts to fit evidence to this new explanatory frame. Specifically, she suggests localizing the problem in an area of the brain through which travel nerves to the leg. Leg clumsiness is one reported symptom for this patient, and as

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such it stands as a fact for which any theory may be held accountable.

If we entertain the possibility that presentation of a theory makes relevant its subsequent acceptance, rejection, or modification, then we might see that Betty presents this second theory while the first theory is possibly still "on the table." Thus, it may be that treatment of the second theory is in some direct way relevant to evaluating the first one. It may be too that this sequencing displays the two theories as part of some larger set of which both are members, and perhaps the only members. Betty links the two theories as a contrastive pair: she refers to this one as "my other theory" and she presents this second one as negation of the first, "not a vascular lesion but a space occupying lesion." In this instance, entertaining one theory involves invoking a domain, ruling out what isn't, perhaps as a way to support an argument for what is.

Response to Theory: Disaffiliation, disagreement, rejection

While the first theory received implicit alignment from Norman and a followup question from Coach, this second theory receives two kinds of responses, each of which shows disaffiliation. First, Maria presents in a question a piece of evidence one would expect to find were this theory to be true.

Betty: where (.) the cortical spinals to the leg would be going through that part.
(1.0)

|0:21:53:00|Maria: Wouldn't you expect to see a lot (1.0) greater involvement if you got internal capsule?

By this question Maria raises an objection to Betty's second theory. Within a few syllables of the beginning of Maria's turn, Norman laughs:

Betty: where the cortical spinals to the leg would be going through that part. (1.0)
|0:21:53:00|Maria: Wouldn't you expect to see a lot
[
|0:21:53:00|Norman: khh hh huh hh

When laughter refers to talk, commonly that talk occurs in the immediately prior utterance (Schenkein, 1972, p. 365). Although we cannot see all the faces on the video, placement of the laugh--shortly following completion of Betty's turn, and before Maria's turn-in-progress has displayed any recognizably laughable features--suggests that it may orient to Betty's talk. If so, it can be heard as disaffiliating from Betty's theory, treating it as not to be taken seriously. Consistent with this interpretation, the Coach provides a stretched, exaggerated response (perhaps "whoa" or "o::kay").

Betty: where the cortical spinals to the leg would be going through that part. (1.0)
|0:21:53:00|Maria: Wouldn't you expect to see a lot=
[
|0:21:53:00|Norman: khh
hh huh hh
[
|0:21:53:00|Coach: Whoa kay
[

|0:21:53:00|Maria: greater involvement if you got

Thus, both Norman and Coach treat Betty's "other theory" as comical, while Maria treats it seriously but disputes it. The other participants remain silent. In short, Betty's second theory gets, not support, but disaffiliative laughter, objection, and silence.

Betty disattends the laughter and answers Maria's objection by producing an explanation for how a lesion could affect only a portion of the brain linking to the leg:

|0:21:53:00|Maria: Wouldn't you expect to see a lot= greater involvement if you got internal capsule?

|0:22:00:00|Betty: [If it's If it's small >I mean if< it's in the very posterior li:mb, (.) posterior part of the posterior li:mb. (1.0) Because there's a- the- (2.0) somato graphic whatever that word was, (.) arrangement of the cordal spinals as they go through the (internal) capsule. If you get way to the posterior ^part of the internal capsule the only thing there is motor and it's going to be the le:g.

Perhaps she does not win over the others to endorsing this theory, but at least they no longer treat it as comic. The Coach shifts from a nonserious reaction to a "Yeah" which echoes Maria's disagreement. Norman aligns with Betty by repeating the word "motor" and assessing the information she has offered as "true."

Betty: where the cortical spinals to the leg would be going through that part. (1.0)

|0:21:53:00|Maria: Wouldn't you expect to see a lot=

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```
                                                [
|0:21:53:00|Norman:                               khh
                        hh huh hh
                                                [
|0:21:53:00|Coach:                               Whoa kay
                                                     [
|0:21:53:00|Maria:                                   greater involvement if you got
                                                          [
           Norman:                                         hh hh
           Norman:      Yeah
|0:21:59:00|Maria:      internal capsule?
                                                        [
|0:22:00:00|Betty:                                      If it's
                        If it's small >I mean if< it's in
                        the very posterior li:mb, (.)
                        posterior part of the posterior
                        li:mb. (1.0) Because there's a- the-
                        (2.0) somato graphic whatever
                        that word was, (.) arrangement of
                        the cordal spinals as they go
                                                              [
           (?):                                               °right°
           Betty:       through the internal capsules.
                                                        [
           (?):                                         Yeah
           Betty:       If you get way to the posterior
                        ^part of the internal capsule the
                        only thing there is motor and it's
                                                             [
           Norman:                                           motor
           Betty:       going to be the le:g.
                                                        [
|0:22:17:00|Norman:                                     motor
           Norman:      That's true
                        (3.0)
```

After a pause, Coach raises another symptom issue for which Betty's second theory should account:

```
           Norman:      That's true
                        (3.0)
|0:22:19:00|Coach:      So why do the leg findings go
                        away?
```

Betty assesses this question as "good" then explicitly acknowledges that it undercuts the possibility of her second theory. She produces reasoning which goes against her own

theory. Maria and Norman join with her in listing symptoms which ought to accompany a space-occupying lesion:

|0:22:19:00|	Coach:	So why do the leg findings go away?
		(1.0)
|0:22:22:00|	Betty:	That's a good question.=That kind of goes against it being some kind of a space occupying lesion because you would expect it to get progressive and then (you want it) to involve more areas.
		(0.4)
	Betty:	So then it's probably
		[
|0:22:32:00|	Maria:	Headaches,
	Betty:	more likely
	Maria:	you would expect
|0:22:33:00|	Norman:	You'd expect to have headaches
|0:22:34:00|	Betty:	°Maybe, yeah.°
|0:22:35:00|	Maria:	Seizures.

The second theory has failed to win support; even its author, Betty, has acknowledged its shortcomings.

(Tentative) Acceptance of First Theory: "If it's vascular..."

After they list symptoms which "you would expect" (but which, by implication, are not present), Betty concludes in favor of the first theory, which invoked circulation problems to account for the patient's symptoms:

|0:22:32:00|	Maria:	Headaches,
	Betty:	more likely
	Maria:	you would expect
|0:22:33:00|	Norman:	You'd expect to have headaches
|0:22:34:00|	Betty:	°Maybe, yeah.°
|0:22:35:00|	Maria:	Seizures.
|0:22:37:00|	Betty:	Um- (0.8) it's more likely to be vascular.

Coach legitimizes this conclusion as valid by his subsequent actions. The token "okay" routinely displays readiness to

move on from current to next items of topic or business (see Beach, 1993); Coach uses it here, and he asks a question which presumes "vascular" to be at least plausible enough to provide a basis for further theory construction:

10:22:37:00	Betty:	Um- (0.8) it's more likely to be vascular.
		(2.5)
10:22:40:00	Coach:	°Okay°
		[
10:22:42:00	Maria:	°With his history and social°
		[
10:22:44:15	Coach:	So
		So if it's vascular did he have a stroke or is he having a TIA. What is the difference between those two things anyway.

The participants have entertained two theories, rejecting the second, and, although not explicitly endorsing the first, at least accepting it enough to use it as a basis for further questioning and theory construction. As our analysis concludes, the group continues discussing the case from the framework of Betty's theory that this patient's problem involves a vascular lesion.

Discussion

PBL participants in this episode orient to theorizing as a central activity. One student presents a theory and supports it with evidence and reasoning, another student displays concurrence with her reasoning, and the coach initiates discussion devoted to clarifying information relevant to the theory. Upon completion of this clarifying task, the same student presents a second theory posed as

alternative to the first. This second theory gets no support from other participants, who respond with silence, critical questioning, and disaffiliative laughter. The presenter herself discounts the second theory and concludes that the first is valid. The coach then uses the first theory, implicitly "accepted" for the moment, as a basis for a subsequent question which leads to presentation of additional information.

In this excerpt, Betty presents her two theories as products of her individual reasoning ("My theory" . . . "My other theory"). However, the "processing" of the theories (including such actions as agreeing, disagreeing, questioning, modifying, etc.) is thoroughly interactional. This collaborative learning exemplifies one primary virtue of the PBL process. Theories survive or fall in a rhetorical, intersubjective, communicative context. This analysis shows Betty's first theory as succeeding, not because of any inherent "truth" or rightness it possesses, but as a result of talk which follows it and the second theory.

The group members orient to theory presentation not only by what they do but also by what they do not do. When Betty announces a forthcoming theory ("My theory") the others grant her extended turn space to present the theory; when theory presentation is complete they treat each theory as topic for subsequent discussion. Were group members to interrupt her before she could present either theory, or ignore the theories once presented, such moves might provide evidence

that participants orient to something other than theorizing as central at these moments in the interaction. To sum up: their displayed orientation to theorizing in this episode is not inevitable but is a product of group members' methodical practices.

The presentation and treatment of theories seems to be one overarching sequential activity in this interaction, but it is not the only one. Glossed over rather quickly in this article are sequences devoted to presenting information (one student reports on distinctions between strokes and TIAs) and clarifying uncertainties (such as the group work of pointing out the hippocampus on flip charts of the brain). In other parts of the PBL meeting there also are instances of casual talk, play and laughter, and meta-level reflection on the process. Related to the preceding point, it can be argued that this interaction involves at least two organizing frameworks or sequential contexts. One is group problem-solving or decision-making. The other is instructional, teacher-student interaction. The two frameworks may differ such that orienting to both creates interactional problems for participants. How they make one or the other framework relevant at particular moments provides an interesting question for further exploration.

In this excerpt, both theory presentations and turns at talk are differentially distributed. One student presents two theories; no one else does. Two students do almost all of the responding to these theories. Were these trends to

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continue for this group, we might easily identify Betty, Maria, and Norman as the most active members. Such distributions provide ways to create, maintain, and modify social interactional roles such as leader, follower, critic, etc., within a group setting. Such a division of labor might be described as a form of "distributed cognition" (Salomon, 1993) in that multiple parties participate in the development of a final theory. Successfully solving problems as a group is thought to contribute to the development of skills that will eventually enable the members of the group to enjoy similar success in individual problem-solving (Feltovich, Spiro, Coulson, & Feltovich, 1996). However, this claim assumes participation by all group members. In the excerpt analyzed here, three members contribute only minimally. Were this to continue, the learning coach might intervene in order to ensure more equitable participation by all of the members of the group.

Although it is not our focus here, one can readily appreciate and study the work involved in serving as coach for a PBL group. The coach intervenes at particular moments and guides the group work in particular ways. According the rules of PBL, the coach cannot provide answers for the students but can display at key points essential reasoning processes (Barrows, 1994; Koschmann et al., in press). In this excerpt, he does so at several points through his summaries and questions.

We ground our claims in a descriptive, inductive method. Such an approach holds great potential for helping researchers understand the interactive processes in PBL group work which are so crucial to its success. We hope that this article serves both to illustrate the possibilities of close description of PBL interaction and to demonstrate conversation analytic description and reasoning. By analyzing additional instances of theory presentation and treatment in PBL groups we may begin to explore the extent to which the features described above are routine parts of such interactions. Presenting one's own ideas and responding to others ideas through questions and assessments are activities common in ordinary conversation as well as in specialized interactions such as PBL groups. Thus, what we learn from analyzing these sessions helps us understand not only PBL groups, but talk-in-interaction in a variety of contexts.

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